HETCH HETCHY PROJECT

by

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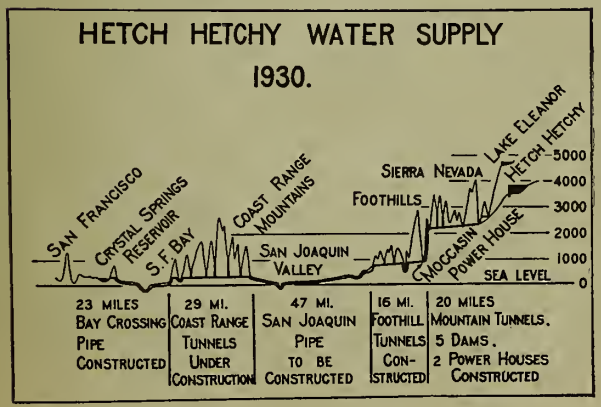

HETCH HETCHY PROJECT

THE Hetch Hetchy Project is being built by San Francisco to furnish two fundamental utilities. The first and most important is an adequate water supply. The second, hydro-electric power, a by-product of the water supply, generated by the fall of the water in its transit from the mountain reservoirs to the San Joaquin Valley, will produce a large revenue to aid in reducing taxes.

There are very few cities in the world that have constructed larger projects. This will supply water enough for a future population of at least five million people. At the present time there are less than one and one-quarter million people on the two sides of San Francisco Bay. Moccasin Power Plant, the first major plant completed, delivers nearly three-fourths of the power now used for all purposes in San Francisco.

Why was it necessary for the municipality to supplant the private corporation supplying water to the City? That company owned the peninsular reservoirs in San Mateo County and the transbay supply from watersheds in Santa Clara and Alameda Counties, a total watershed of 62,000 acres. The City, comprising 27,000 acres of land, reached the limit of its demand on the capacity of the peninsular lakes in 1888. The transbay sources were then added and are now furnishing two-thirds of the total supply. Investigations proved that it was wiser for San Francisco as a City to create all further additions to the water supply which must be made. Because of the magnitude of the undertaking and because it is the accepted policy for all progressive cities of this size to be free from private control of a water supply, it became the duty of the City Government to underwrite the project.

A few years prior to 1908 investigations of possible municipal sources were started. Fourteen supplies throughout central and northern California were studied by engineers. They reported Hetch Hetchy to be the best in quality, power possibilities, and least expensive to construct and operate. Because the proposed reservoirs were in the Yosemite National Park, permission for the construction had to be granted by the Federal Government. This limited permission was first given San Francisco by Secretary of the Interior Garfield, after eight years of waiting, in 1908. Two years later, in 1910, the people by a twenty to one vote, authorized $45,000,000 in bonds to build the system.

Then the trouble began. Opposition cropped out from four sources: by the private Spring Valley Water Company, the Turlock-Modesto Irrigation Districts, power promoters, and sentimental nature lovers. It required four years to satisfy the Federal Government in Washington that there were more reasons to justify San Francisco's application than objections presented by opposing forces.

It was finally settled by Act of Congress in 1913 granting rights to San Francisco to build dams and use water from this watershed of 420,000 acres in the northern part of Yosemite National Park. There were many points in the Act limiting San Francisco's rights and making certain demands: (1) most important was the agreement that the farmers on the Tuolumne River would be assured the same amount of water for irrigation that they hitherto had been using; (2) San Francisco must build hydro-electric power plants early in the construction program; (3) San Francisco is now paying $20,000 and must ultimately pay the Government $30,000 tolls annually as rental for use of lands belonging to the Government of the United States.

Actual construction work began in July 1914, the same year and time that the Great War started. The policy adopted was to build that part first which would bring a quick return on the investment. That means the 100,000 h.p. Moccasin Power Plant which has been producing power since 1925. The present need for water in San Francisco may be met by the resources of the Alameda Creek properties for a period of three years. However, as the Bay Crossing pipes were inadequate to carry the additional water from Alameda County, San Francisco built the Bay Division portion of the Hetch Hetchy aqueduct, twenty-two miles long, costing $6,000,000 (completed in May 1926) and uses it to carry additional water from the Alameda Creek system. Note that the two ends of the project are completed (1) to bring an income from power from the mountain end while the remainder is being built, and (2) to avoid local water shortage in San Francisco resulting from inadequate Spring Valley water pipes across the Bay.

Since 1858 water has been supplied to San Francisco by the Spring Valley Water Company. In 1922 the City secured an option to purchase all the company's properties, including over 62,000 acres, also all dams, pipes, reservoirs and services, during a period expiring in 1933, for $37,000,000 plus any capital extensions made to

the system. This purchase was approved by a popular vote of over four to one on May 1, 1928, with over 100,000 votes cast. The City of San Francisco assumed possession of Spring Valley on March 3, 1930, for a consideration of approximately $40,000,000.

Now to give you a general idea of the Hetch Hetchy project:

There are now two main storage reservoirs completed, Hetch Hetchy Lake with 67 billion gallons, 3700 feet above the sea, and Lake Eleanor four miles northwest from Hetch Hetchy with 8 billion gallons, 4660 feet above the sea, draining a distinctly separate watershed. The outlet from Eleanor is Cherry River, tributary to the Tuolumne River, with which it unites at a point about 13 miles below Hetch Hetchy. At Early Intake on the Tuolumne River, 2326 feet elevation, 12 miles below O'Shaughnessy Dam, we have made the entrance to our 10 ft. 3 in. diameter tunnel aqueduct. This tunnel, twenty miles long, with a fall of 8 feet per mile, carries 470 million gallons of water daily. From Priest Reservoir at the end of this first tunnel, this water drops 1316 feet vertically, through four penstock pipes to Moccasin Powerhouse at 926 feet elevation, to rotate 8 giant water wheels and produce 1⅓ million kilowatt-hours of energy each day. Below the power house the water is again caught by a dam, the sixth on the system, to continue its way in a 16 mile tunnel through the foothills, with inlet elevation 888 feet, to the eastern edge of the San Joaquin Valley, about 3 miles southeast of Knights Ferry.

It crosses that Valley for 47 miles in a steel pipe, to Tesla Portal, 7 miles south of Tracy, through the hills in Alameda County by 29 miles of tunnel, terminating at Irvington, across San Francisco Bay by submarine pipe and bridge at Dumbarton Strait, and then by pipe and tunnel into Crystal Springs Reservoir just outside the City, delivering water at 290 feet above the sea. Thus you have all gravity flow from two reservoirs in the high Sierra through tunnels, power house and pipe line into the lakes in San Mateo County now used for storage of San Francisco water. The whole length is 167 miles from Hetch Hetchy, 12 miles Tuolumne River bed, 85 miles tunnels, (everlasting, and maintaining the purity of the water,) and 70 miles of pressure pipes.

Hetch Hetchy Reservoir is formed by the O'Shaughnessy Dam and the Tuolumne River. The valley originally had a flat, sandy floor, the river winding across it, and contained scattered groups

of trees which were removed. It was at one time occupied by a huge glacier which carried large boulders and deposited them in the neck where the dam is now built. The falls on the left are called Tueeulala, and those on the right Wapama. The tall cliff between them is El Capitan Jr. The high peak on the south side is Kolana Rock. One can see how the shape of the valley makes it an ideal reservoir: (1) because the bottom is flat, and (2) because the walls are steep and inaccessible for travelers. The greatest width is 2-3 of a mile; this main part being 1 1-2 miles long, and the total length 7 miles (very narrow above Kolana Rock). Future addition to the height of the dam will make this lake 310 feet deep. The present reservoir when full is 225 feet deep and holds as much water as San Francisco uses in four years and this can all be caught here each flood season in two weeks.

O'Shaughnessy Dam is the largest of the six dams now completed, with 398,000 cubic yards of concrete. It is called a gravity-arch type. It is one of the six largest dams in the world. Gravity pull on the great mass and width of the base is enough to resist all push by the water on the upstream side. The quantity of concrete used would be sufficient to build a concrete highway of usual dimensions from Hetch Hetchy to San Francisco—170 miles. It required 3 1-2 years to build, and cost near $7,000,000. Excavation for a firm foundation extended a maximum of 118 feet through boulders and gravel below streambed. There are 227 feet above streambed, a total height of 345 feet. Only one dam in this country is higher —Arrowrock Dam, Idaho, 10 feet more in total height. Here is a point to note: this foundation is now built and extended 80 feet down stream below the toe of the dam to carry the ultimate dam, which will be 85 feet taller and hold 348,000 acre-feet or 113 billion gallons of water. The two ends are thinner than the center section. When water demands of the City require more storage capacity here, those ends will be thickened to equal the center and 85 feet of height added to the crest. That will add 70 per cent to the lake capacity.

It is interesting to note what was done to by-pass the stream while building the dam. A tunnel 1000 feet long was driven in the rock on the south side of the channel. It is 23 feet wide by 25 feet in height—once and one-half the size of Twin Peaks Tunnel, and remains with three valves in it as the lowest outlet through the dam.

There are nine other outlets through the dam: six are 5 foot conduits containing balanced valves in the thick center section. They are used to discharge water from the lake through the dry season as it is needed for the City. There are five expansion joints fitted with copper plate water stops, to obviate temperature stresses, in the length of the dam.

The dam at Lake Eleanor will also be built over 150 feet higher, of rock fill, when the proper time comes. Although all materials and supplies had to be hauled in trucks over difficult roads 12 miles across the mountains from Hetch Hetchy, the present structure was built by the City's engineers in the remarkably short time of nine months. It is 1200 feet long by 70 feet high, with 20 concrete arches, and cost about $300,000.

So much on storage reservoirs.

The aqueduct—the greatest expense on the project—will maintain the extraordinary purity of Hetch Hetchy water by carrying it inclosed by tunnels and pipe all the way—no open ditches. As it leaves the mountain reservoirs the water is satisfactory for automobile storage batteries.

Does anyone want to guess how much it costs per linear foot to drive tunnel through the solid granite? It has to be drilled by punching 40 drill holes into the granite every 10 feet of length and blasted, using $7.00 worth of powder to each lineal foot, to a 12 foot section and then lined with 6 inches of concrete. The cost runs from $68 to $82 per foot. There are 85 miles of tunnels planned—not all as expensive, however.

A word in regard to the big power plant now completed at Moccasin, 34 miles below Hetch Hetchy. Priest Dam, 145 feet high, was built to make a regulating reservoir of 1 billion gallons capacity. The power house contains four generators driven by eight 12 ft. 4 in. water wheels, of 100,000 h.p. total capacity. To get water to these wheels two 9 foot pipes branch successively into four 5 1-2 foot pipes and finally into eight 3 foot pipes of heavy welded steel. Since August 21, 1925, this plant has produced electric energy worth $2,300,000 wholesale each year. Power sales passed the $10,000,000 mark in March 1930.

Have you ever thought of the great amount of preliminary work and expense on a project like this?

Transportation—a 68 mile standard gauge railroad was built

and equipped at a cost of $3,000,000. Also wagon roads—many miles of them. A sawmill built by the City, furnished millions of feet of lumber used for tunnel work, railroad and buildings. A construction power plant using water from Lake Eleanor and Cherry River supplied all electric energy needed in the mountain work for air compressors, lights, fans, etc. Surplus energy from this plant has been sold through a power company, bringing a total income to date of over $500,000.

By the end of 1929 all units of the work had been completed except the Coast Range tunnel and the San Joaquin Valley pipe line. It is expected that these will be completed in 1932.

The Coast Range tunnel is 28.6 miles long. It extends from Tesla Portal, 7 miles south of Tracy, to Irvington Portal, near the town of Irvington. At present (March 1930) 1200 men are employed in this construction and ten miles of tunnel have been driven. Five shafts, two of them over 800 feet deep, were sunk to facilitate the work and tunneling is carried on in both directions from the bottom of each shaft, and from four portals, or from 14 working faces in all.

Construction of the San Joaquin pipe line will be begun when the tunnel work is a little further advanced, so that these two units may be completed simultaneously.

Compared to Los Angeles Water Supply:—

The Hetch Hetchy Water Project will deliver 470 million gallons daily to their 275 million gallons daily, and more electric power. It has twice the mileage of tunnel, no open canal, more permanent dams, and more capacity. The water at Hetch Hetchy Lake is seven times the present storage of Los Angeles. Since the Los Angeles system was built, labor cost jumped from $2.50 to $4.50 per day; powder jumped 300 per cent; interest on bonds from 4½ per cent to 5½ per cent. Los Angeles is now proposing to spend $250,000,000 more to bring additional water from the Colorado River and $40,000,000 for further development around Mono Lake.

The Hetch Hetchy work has been financed from four bond issues; $600,000 in 1909; $45,000,000 in 1910; $10,000,000 in 1924; and $24,000,000 in 1928—a total of $79,600,000.

The project has been characterized by especially careful plans and by first class engineering construction.